



Diurnal Activity Patterns and Social Behaviour of *Colobus Guereza Gallinarum* in Bale Mountains National Park, Southeast Ethiopia

Israel Petros^{1☀}, Sefi Mekonen², Hussein Gena³, Yared Mesfin⁴

1.Department of Biology, Dilla University, Ethiopia

2.Department of Wildlife and Ecotourism Management, Wolkite University, Ethiopia

3.Department of Ecotourism and Biodiversity Conservation, Madda Walabu University, Ethiopia

4.Department of Natural Resource Management, Arsi University, Ethiopia

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General Note

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ABSTRACT

The study of diurnal activity patterns and social behaviour of *Colobus Guereza Gallinarum* was carried out from February to July 2016 in Bale Mountains National Park. Ten-min focal animal sampling techniques were obtained from different troops and age-sex classes of the animal to study activity patterns and social behaviours. The activity budget was carried out grouping the behavioural categories into feeding, travelling, resting, scanning, self-grooming, social behaviours and other behaviours. The social behaviour of *C. g. gallarum* was studied using all-occurrence sampling. A total of 649 scan samples were recorded during the wet season and 823 samples were recorded for the dry season. Of these recorded time budgets, 33.02% was for resting, 23.57% for scanning, 17.00% for feeding, 14.33% for traveling, 5.43 % for self-grooming, 4.21% for social behaviours and 2.45 % for other activities. All individuals of *C. g. gallarum* on an average spent more time for resting followed by scanning and feeding in both seasons. In both wet and dry

seasons, the major time spent was for resting, followed by scanning during the morning time while, the greatest time was devoted for resting and feeding during the afternoon time. Play (50.00%) was the dominant social activity followed by affiliation (26.39%). Out of 129 affiliation and 13 aggressive recorded activities, adult females had both high (48) affiliation and aggressive (6) behaviour followed by sub-adult female (38, affiliation and 2, aggressive) and sub-adult male (29, affiliation and 3, aggressive). However, adult males have less recorded affiliative (14) and aggressive (2) behaviour among social classes of *Colobus Guereza Gallinarum*. This study provides baseline information on behavioural ecology of *Colobus Guereza Gallinarum* and it help to give information related to time spent in looking for food and habitat quality for the conservation since has not been documented in the area.

Keywords: Activity Pattern, *Colobus Guereza Gallinarum*, Social Behaviour

1. INTRODUCTION

Black and white colobus monkeys, or guerezas (*Colobusguereza*), are among the few primate species which is a large glossy black monkey with a white mantle and a tail tuft. It characterized by having mainly black, short-haired tails with a small amount of white at the tip, forming apompom (Rabineau, 2009). Black-and-white colobus (*Colobusguereza*) are an arboreal Old World primate taxon inhabiting the deciduous and evergreen forests of several African countries (Jensz, and Finley, 2011; Fashing and Oates, 2013). They are predominantly found in forests and savannah woodlands within, and to the north, of the moist forests of central Africa, often extending into highland or mountain forests (Oates, 1994).

According to Fashing and Oates (2013), eight subspecies of *Colobusguereza* are currently recognized based on morphological variation. However, no molecular genetic study has been carried out in these species and the taxonomy remains vague and inconclusive (Kingdon *et al.*, 2008). Two of the subspecies are endemic to the Ethiopian highlands, *C. g. gallarum* east of the Rift Valley including Bale Mountains National Park and *C. g. guereza* west of the Rift Valley. *C. g. gallarum* is commonly called Djaffa Mountains Guereza. Little is known about the ecology of this taxon and it is recognized as Data Deficient by IUCN by IUCN (Gippoliti and Butynski, 2008).

Numerous species of primates inhabit lower quality forest habitats but are capable of surviving; therefore, research will expand the understanding on their behavioural ecology (Wong, 2007). According to Cristobal-Azkarate and Arroyo-Rodriguez (2007) and Riley (2007), primates' behavioural activities can be determined by habitat types in which they are living. This is influenced by the availability of food, water, cover, and other environmental factors (Fernandez-Duque, 2003; Cristobal-Azkarate and Arroyo-Rodriguez, 2007; Riley, 2007). Activities of primates living in a variety of habitats depend on group size, site, time of the day/year and individual variation. Some groups (age groups) tend to spend much time feeding while other groups spend more time grooming, playing and moving (Fernandez-Duque, 2003).

The studies in primate behaviour including black-and-white colobus monkeys in different forest fragments can help to give information related to time spent in looking for food and habitat quality (Wong, 2007; Boyle, 2008). In high quality habitat, individuals should spend less time travelling and foraging compared to lower quality habitat whereby it affects the normal activity pattern (Wong, 2007; Eustace *et al.*, 2015). Therefore, we decided to analyses the activity patterns and social behaviour of *Colobus Guereza Gallinarum* in Bale Mountains National Park. Given the lack of knowledge concerning the subspecies and the conservation priorities linked to its future existence in Ethiopia, we aimed to study the activity pattern and the social behaviour of *C. g. gallarum*.

2. METHODOLOGY

Study Area Description

The study was conducted in the Bale Mountains National Park (BMNP) in the Oromiya administrative regional state southeast Ethiopia. BMNP is found 440 km far from the central city of the country, Addis Ababa and located at 6°29' – 7°10'N and 39°28' – 39°57'E. The park belongs to the Bale-Arsi massif, which forms the western section of the south-eastern Ethiopian highlands covering 2200km² (Alers *et al.*, 2007; Gashaw, 2015). The BMNP is one of the parks in Ethiopia that harbor a diverse range of endemic fauna and flora, and is part of the Eastern Afroalpine Biodiversity Hotspot. It is also one of the 34 international biodiversity hotspots and qualities for the World Heritage Site and Biosphere reserve (IBC, 2007).

It was first proposed in the late 1960s to protect Afroalpine habitat and populations of the rare, endemic species of the Mountain nyala (*Tragelaphus buxtoni*) and the Ethiopian wolf (*Canis simensis*) (Bird Life International, 2001; IBC, 2007). Bale Mountains National Park is one of the most important areas of the world for its number of threatened Ethiopian endemics in all taxa, harboring 26% of the country's endemic species, 6% of the recorded birds species in the area are endemics to Ethiopian. In addition,

there are several rare and endemic amphibian species found only in Bale as well as 1321 species of flowering plants with 163 endemic (23 to Bale alone) to Ethiopia.

Method of Data Collection

Activity Pattern (Behaviour)

Data were collected on troops of *Colobus Guereza Gallinarum*. The behavioural study was carried out for 6 months in both dry (February, March and April) and wet (May, June and July) seasons in 2016. During the investigation, field survey was made for 8 days every month. The troops were studied at the level of age-sex class due to shortage of time to be familiar with study troops before the research work. The behavioural study was carried out for 8 days. Troops were followed by four researchers and, local field assistant.

The behavioural study focused on different age and sex class of the troops. Identification of sex and age categories was carried out using relative body size and external genitalia. Ten-min focal animal samples were obtained from different troops and age-sex classes (Pavelka and Knopff, 2004).

Behavioural data were collected selecting one individual (focal animal sampling) from the sample and recording all the behavioural events this individual display in a predetermined sample period. The behavioural events of an individual were distinguished and the frequency of each of the activities in the allocated time period interval were recorded (Altman, 1974). All behaviours of the focal animal were recorded and the exact start and stop time of each behaviour were noted (Ellwanger and Gould, 2011). The focal animals were followed for ten minutes with five minutes break in between. The selections of an individual were made randomly among males, females, juveniles and sub-adults. Focal animals were observed until they are lost from sight for a continuous period of over 10 minutes or could not be located again.

Analysis of the activity budget was carried out by grouping the behavioural categories into seven discreet categories: Feeding, Travelling, Resting, Scanning, Self-grooming, Social behaviours and other behaviours (Isbell and Young, 1993). Behaviours categorized as 'other' refers to activities which are not regularly observed (Sam and Noga, 2011). The activity budget was compared among the troops and social classes.

Major behavioural categories observed and definitions are the following:

- Resting: The state at which individuals are inactive. e.g. sitting, sleeping
- Traveling:- Moving from one place to another or changing location within one tree or between trees without involving in another activities. e.g walking, running, jumping
- Social behaviour:- Interactions among individuals, e.g. playing, aggression, mating, calling
- Feeding: Searching, chewing, eating, breaking or handling of food items e.g. fruit, leave
- Auto-grooming:- Refers to self- grooming of focal animals
- Scanning: The state at which individuals scan their environment through checking their environment
- Others behaviours: - Activities displayed by individuals as a response to internal and external stimuli, and not encompassed above. e.g. defecating, urinating, auto-grooming, scanning

Social behaviour

The social behaviour of *C. g. gallarum* was studied using all-occurrence sampling (Altmann, 1974). Three main types of social behaviours such as affiliative (grooming interactions, approach, play and call-localization), agonistic and scent marking were recorded (Ramanamisata *et al.*, 2014). These three main social activity categories were separately recorded. The proportions of time spent in different social activities were calculated and the dominant behavioural events among social classes of the troops were distinguished (Kirkpatrick *et al.*, 1998). The affiliative and agonistic social activities were analysed comparing among male, female, adults and sub adults. Moreover, data analysis was also performed by averaging interaction types overall between both sexes.

To assess the social dominance, the social status of an animal, relative to others in a group, was determined by the outcome of social encounters. When all aggression is observed, the identity and sex of the individual director (i.e., who initiated the attack) and receiver (i.e., who suffered the attack) was noted, together with the context in which the aggression was occurred (Ramanamisata *et al.*, 2014). The social dominance was measured by the number of encounters in which an animal displaces (is dominant) or is displaced (is subordinate) another animal; simply the number of displacements it receives and gives.

Data Analysis

SPSS version 21 software was used to analyse diurnal activity pattern and social behaviour of the target animal. One way ANOVA, t-test, percentage and mean were used to compare the proportion of time that the different group members and individuals used for different activities.

3. RESULT

Activity Patterns of *Colobus Guereza Gallinarum*

Seven main categories of activities were observed. A total of 1472 behavioural data were made available for the wet (April, May and June) and dry (February and March) seasons (Table 1). A total of 649 scan samples were recorded during the wet season and 823 samples were recorded for the dry season. The recorded time budget was 33.02 % for resting, 17.00% for feeding, 14.33% for traveling, 5.43 % for grooming, and 23.57% for scanning, 4.21% for social behaviours and 2.45 % for other activities. All individuals of *Colobus Guereza Gallinarum* on an average spent more time for resting followed by scanning and feeding. Other behaviour was the least for which they spent 2.45% of the total time of observations.

Table 1 Percentage of time spent in different activities by the *Colobus Guereza Gallinarum*

No.	Activities	Total record	Percent
1	Rest	486	33.02
2	Feed	250	17.00
3	Travel	211	14.33
4	Grooming	80	5.43
5	Scanning	347	23.57
6	Social	62	4.21
7	Other	36	2.45
Total		1472	100.00

Seasonal activity time budget of *Colobus Guereza Gallinarum* is as follows; during both dry and wet seasons, the major time spent was for resting, followed by scanning and feeding. Both social and other behaviour are the least activities in both seasons accounting less than 5% from the overall activities. The wet and dry seasons activity time budget are described in Figure 1.

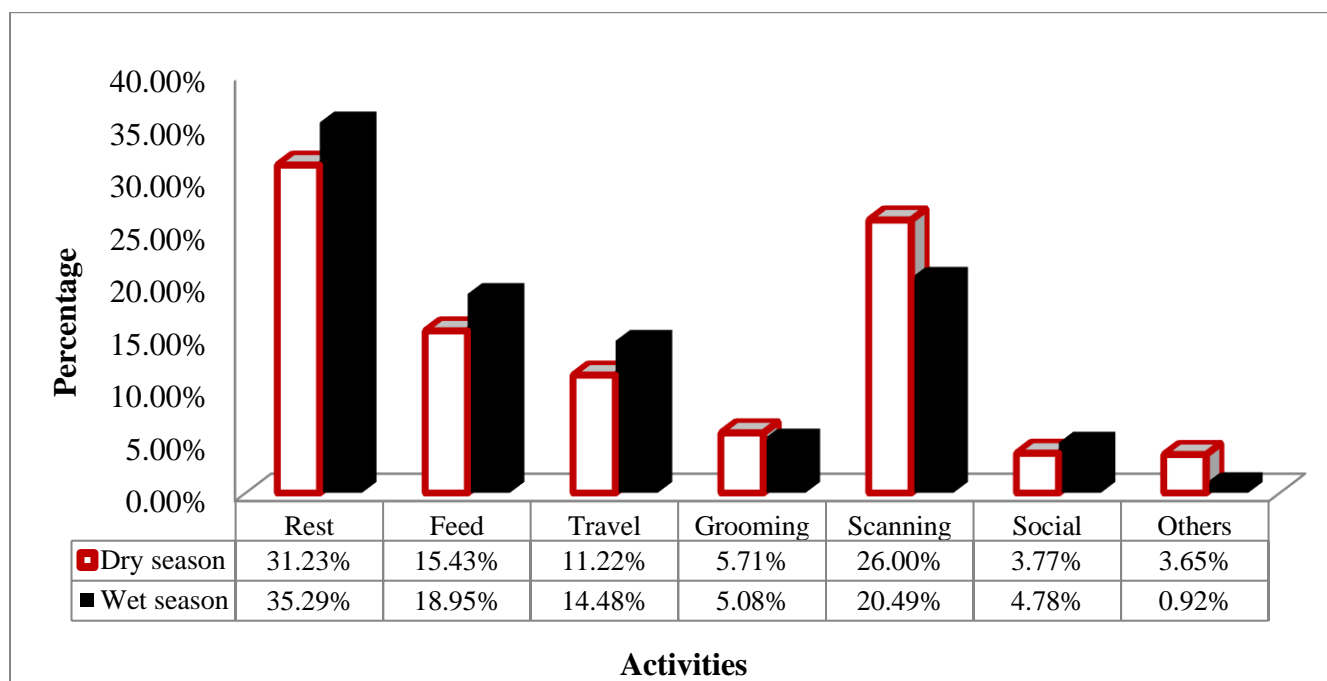


Figure 1 Percentage contribution of activities of *Colobus Guereza Gallinarum* during the wet and dry seasons

Morning and afternoon activities of *Colobus Guereza Gallinarum*

The diurnal activity of *Colobus guereza gallarum* is as follows; during the morning time, the major time spent was for resting, followed by scanning in both wet and dry seasons. During the afternoon activity period season, the greatest time was devoted for resting and feeding. Travelling and scanning are also among the main activities in the afternoon time period. The morning and afternoon activity patterns are described in Figure 2.

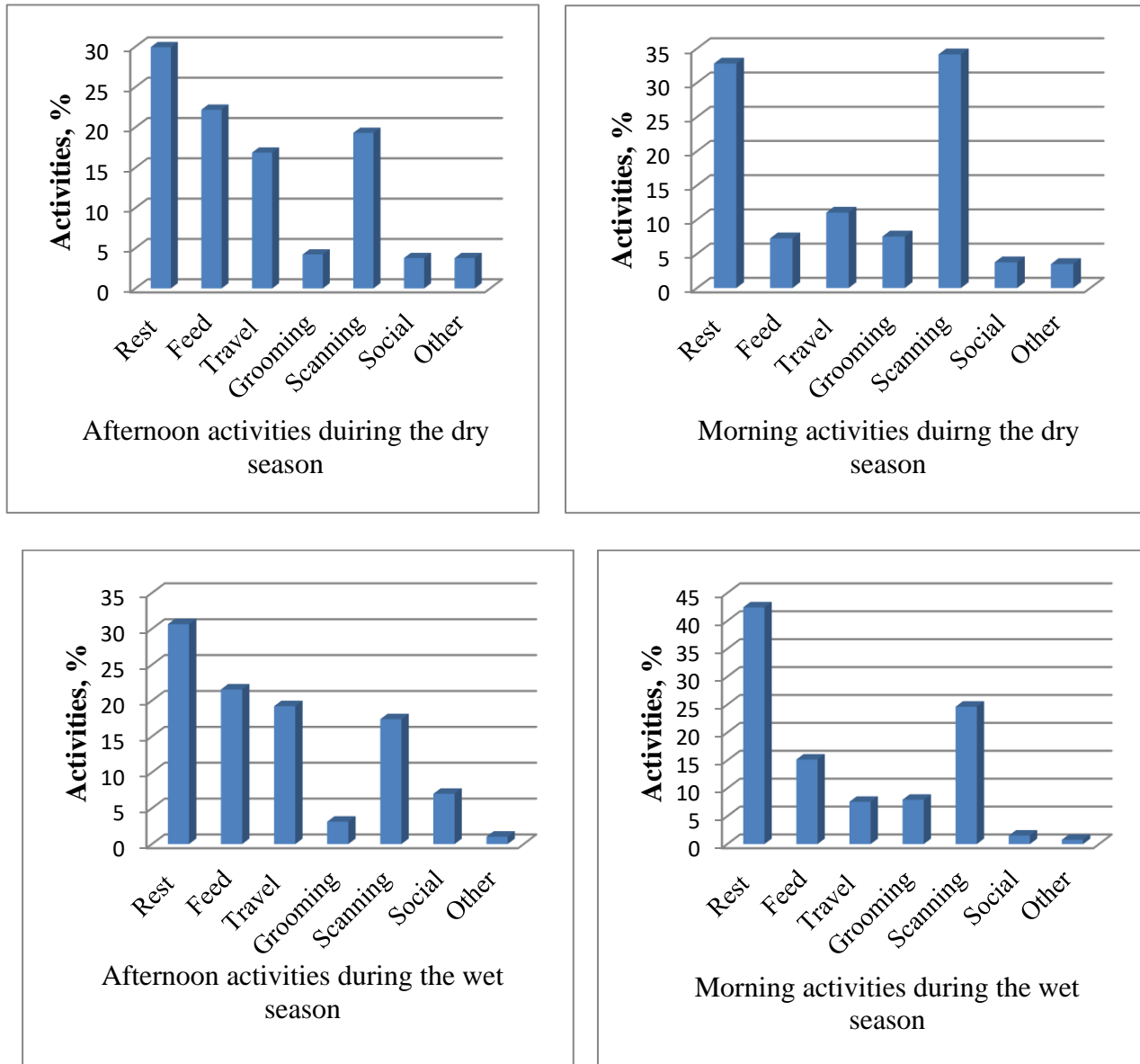


Figure 1 The morning and afternoon activity patterns of *Colobus Guereza Gallinarum*

Social Behaviour of *Colobus Guereza Gallinarum*

The social behaviour of *Colobus guereza* is characterized by affiliative, aggressive and scent marking in the area. Play was the dominant social activity recorded during the study. Affiliation was the second social activity followed by aggression and grooming interactions. Scent marking and calling were the lowest social activities recorded accounting less than 5% (Table 2).

Table 2 Social activities of *Colbus guereza gallarum* and their percentage contribution

No	Type of social behaviour	Frequency	Percent
1	Affiliation with physical contact	38	26.39

2	Play	72	50.00
3	Grooming interactions	12	8.33
4	Calling	7	4.86
5	Aggression	13	9.03
6	Scent marking	2	1.39
Total		144	100

The comparison of social activities such as affiliation and aggressive among social classes of *Colobus Guereza Gallinarum* indicated the high affiliation and aggressive behaviour in adult females (48 and 6, respectively). Sub-adult male (29) and female (38) have also high records of affiliative behaviour due to playing. But, adult males have less records both affiliative and aggressive behaviour (14 and 2, respectively) (Fig. 3).

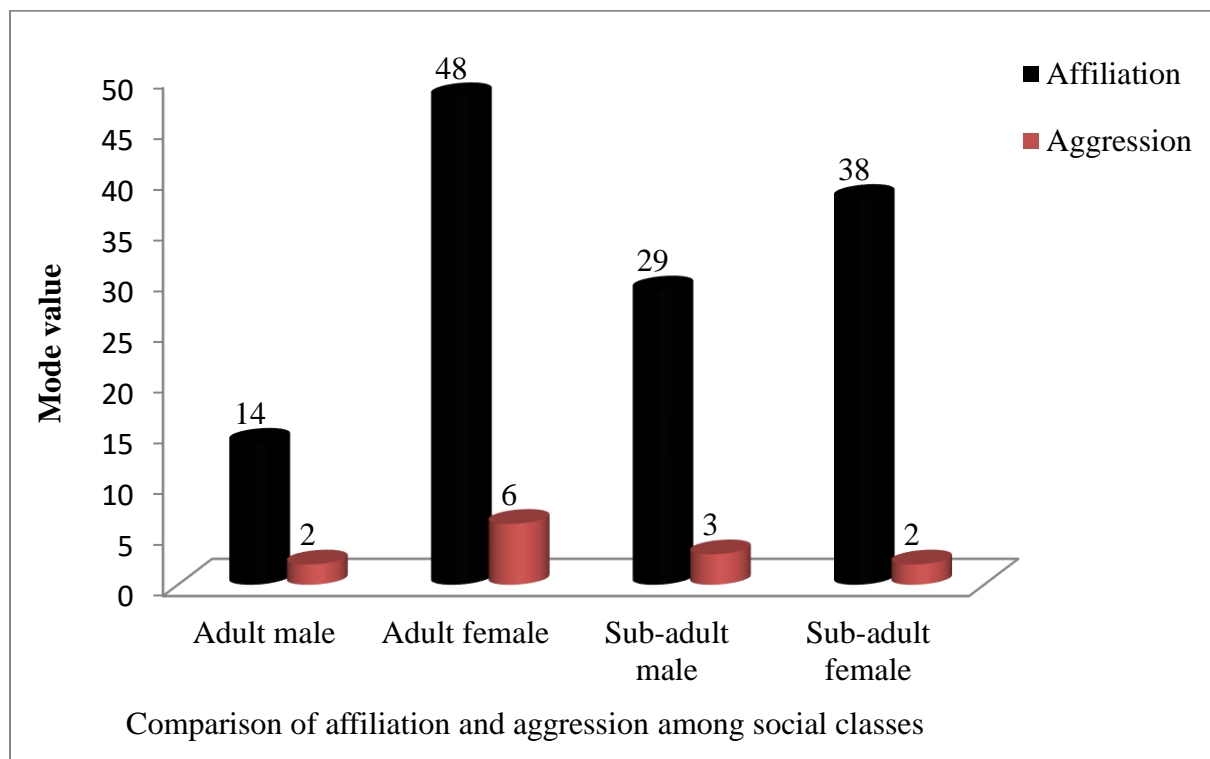


Figure 3 Comparison of social activities between population structures of *Colobus Guereza Gallinarum*

4. DISCUSSION

The possible reasons of various frequencies of behavioural events of the animal might be related to the presence of disturbances, hunger, playing, aggressive and mating events (Sefi Mekonen and Birnesh Hailemariam, 2016). Similar to other studies on activity of black-and-white colobus subspecies, all individuals of *Colobus Guereza Gallinarum* spend most of their time on resting followed by scanning and feeding (Table 1 and Fig. 1) (Fashing, 2001). Travelling was the next main activity. Other behaviour was the least for which they spent 2.45% of the total time of observations. Dereje Tesfaye (2016) was also studied on activity of *Colobus Guereza Gallinarum* in other Ethiopian highlands and he stated that *Colobus Guereza Gallinarum* spent much time resting and feeding similar to the present study. As discussed by other authors, high resting might be due to behavioural thermoregulation with *Colobus guereza* resting under shaded tree canopies during midday and in sunny canopies in the morning and evening (Dasilva, 1992; Fernandez-Duque, 2003). Also much time in resting might be needed to assist food digestion as colobus monkeys feed on cellulose-rich food materials requiring long gut passage times (Dasilva, 1992; Eustace *et al.*, 2015).

Colobus Guereza Gallinarum in Bale Mountains National Park spent more time resting and feeding than moving or social activities (Fig.1 and Table 1). This variation in activity can also be due to energy conservation strategies (Eustace *et al.*, 2015). As a result of energy conservation, colobus monkeys tend to move short distances and spend much time resting while feeding on the abundant food available (Fernandez-Duque, 2003; Eustace *et al.*, 2015). Difference in activity with other studies (Table 1) might be

due to variations in habitats and subspecies (Eustace *et al.*, 2015). Data collection techniques also lead to differences in activity from one study to another. These differences in data collection methods may impact findings (Fernandez-Duque, 2003; Eustace *et al.*, 2015).

Travel and feeding activity also might be influenced by the availability of seasonal food sources. Different food items such as flowers, fruits or seed pods, often available in widely dispersed food trees, might require more travel or even feeding time than typically more abundant leaves.

The diurnal activities of *Colobus guereza gallarum* were varied (Fig. 3) as follows; during the morning time, the major time spent was for resting, followed by scanning in both wet and dry seasons. However, during the afternoon activity period season, the greatest time was devoted for resting and feeding. Travelling and scanning are also among the main activities in the afternoon time period. Black-and-white colobus species activities vary substantially in the time they spend feeding, traveling and resting during the day (Bocian, 1997; Fashing, 2001a).

Moreover, activities of *Colobus guereza gallarum* in BMNP varied but not significantly over the course of the day. Resting tends to be at high in all times of the day but peak in the evening. Feeding tended to be higher in the morning and evening, suggesting that colobus monkeys feed more at cooler times of day. Movements were negatively correlated with feeding, peaking in the afternoon and less in the morning and evening, suggesting that black-and-white colobus monkey move less when they are feeding. The results for daily patterns of resting and feeding activities are consistent with other published studies of colobus monkeys daily activity. And also feeding activities tend to increase from morning to evening, major movements tend to occur in the late afternoon and resting tends to remain constant throughout the day (Eustace *et al.*, 2015).

Among social classes of *Colobus Guereza Gallinarum* the high affiliation and aggressive behaviour were recorded in adult females. But, adult males have less records both affiliative and aggressive behaviour. The reasons might be, females were more aggressive and vocalized when in defense of the young offspring from the males or from possible disturbances (Sefi Mekonen and Birnesh Hailemariam, 2016).

5. CONCLUSIONS AND RECOMMENDATIONS

Overall activities of *Colobus Guereza Gallinarum* do vary, as they spent more time for resting, scanning and feeding and travelling while spending less time in social activities like grooming. These variations in overall activity are due to energy conservation strategies and more time for digesting cellulose food materials hence more resting time. The social behaviour of *Colobus Guereza Gallinarum* is characterized by affiliative, aggressive and scent marking in the area. Play was the dominant social activity recorded followed by affiliation, aggression and grooming interactions. However, scent marking and calling spent the lowest social activities recorded in the study area. This study on behavioural ecology of *Colobus Guereza Gallinarum* in Bale Mountains National Park has been provides baseline information for the conservation of the species since little has been documented in the area. The results will be used for planning conservation strategies as *Colobus Guereza Gallinarum* is locally threatened. Conservation program for endemic *C. g. gallarum* in the BMNP should be established. Further study also should be promoted to know more about the population dynamics, reproduction and other ecological and behavioural aspect of *C. g. gallarum* in Bale Mountains National Park.

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